

Radiation image storage panel

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Abstract of EP0234385

A radiation image storage panel comprising a support and a phosphor layer provided on the support which comprises a binder and a stimuable phosphor dispersed therein, characterized in that said stimuable phosphor is a phosphor containing iodine and that said phosphor layer contains a compound having an epoxy group and/or at least one compound selected from the group consisting of phosphites, organotin compounds and metal salts of organic acids.

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Radiation image storage panel

Description of **EP0234385**

RADIATION IMAGE STORAGE PANEL

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a radiation image storage panel employed in a radiation image recording and reproducing method utilizing a stimuable phosphor. More particularly, the invention relates to a radiation image storage panel using a stimuable phosphor containing iodine.

Description of the Prior Art

For obtaining a radiation image, a radiation image recording and reproducing method utilizing a stimuable phosphor as described, for instance, in U.S. Patent No. 4,239,968, has been recently proposed and put into practice. In the method, a radiation image storage panel comprising a stimuable phosphor (i.e., stimuable phosphor sheet) is used, and the method involves steps of causing the stimuable phosphor of the panel to absorb radiation energy having passed through an object or having radiated from an object; sequentially exciting the stimuable phosphor with an electromagnetic wave such as visible light or infrared rays (hereinafter referred to as "stimulating rays") to release the radiation energy stored in the phosphor as light emission (stimulated emission); photoelectrically detecting the emitted light to obtain electric signals; and reproducing the radiation image of the object as a visible image from the electric signals.

According to this method, a radiation image is obtainable with a sufficient amount of information by applying a radiation to an object at considerably smaller dose, as compared with a conventional radiography employing a combination of a radiographic film and a radiographic intensifying screen. The method is of great value especially when the method is used for medical diagnosis.

The radiation image storage panel employed in the above-described method has a basic structure comprising a support and a phosphor layer provided on one surface of the support. Further, a transparent film of a polymer material is generally provided on the free surface (surface not facing the support) of the phosphor layer to keep the phosphor layer from chemical deterioration or physical shock.

The phosphor layer comprises a binder and stimuable phosphor particles dispersed therein. The stimuable phosphor emits light (gives stimulated emission) when excited with an electromagnetic wave (stimulating rays) such as visible light or infrared rays after having been exposed to a radiation such as X-rays. Accordingly, the radiation having passed through an object or radiated from an object is absorbed by the phosphor layer of the panel in proportion to the applied radiation dose, and a radiation image of the object is produced in the panel in the form of a radiation energy-stored image. The radiation energy-stored image can be released as stimulated emission by sequentially irradiating (scanning) the panel with stimulating rays. The stimulated emission is then photoelectrically detected to give electric signals, so as to reproduce a visible image from the electric signals.

The radiation image recording and reproducing method is very useful for obtaining a radiation image as a visible image as described hereinbefore, and it is desired for the radiation image storage panel employed in the method to have a high sensitivity and provide an image of high quality (high sharpness, high graininess, etc.), as well as the radiographic intensifying screen employed in the conventional radiography. Especially when the object is a human body, the sensitivity of the panel is desired to be as high as possible to reduce a radiation dose applied to the human body.

As a stimuable phosphor employed in the radiation image storage panel, there has been proposed

phosphors containing iodine as a component thereof such as a divalent europium activated barium fluorohalide phosphor (BaFX:Eu^{2+} , in which X is I or a combination of I and Cl and/or Br), a divalent europium activated barium halide phosphor (BaXX':Eu^{2+} , in which each of X and X' is at least one halogen selected from the group consisting of Cl, Br and I, X NOT EQUAL X', and at least one of X and X' contains I), a cerium activated rare earth oxyhalide phosphor (LnOX:Ce , in which Ln is at least one rare earth element selected from the group consisting of Y, La and lanthanides; and X is I or a combination of I and Cl and/or Br), and a bismuth activated alkali metal halide phosphor (M<I>X:Bi , in which M<I> is Rb and/or Cs; and X is I or a combination of I and Cl and/or Br).

However, when these stimuable phosphors containing iodine are used in the radiation image storage panel, the phosphor layer is liable to be colored yellow gradually because the iodine is liberated from the phosphor to produce an iodine molecule (I_2). Such yellowing of the phosphor layer causes a problem of prominently decreased sensitivity in the panel.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a radiation image storage panel prevented from being colored yellow.

It is an object of the present invention to provide a radiation image storage panel improved in the sensitivity.

The object can be accomplished by a radiation image storage panel comprising a support and a phosphor layer provided on the support which comprises a binder and a stimuable phosphor dispersed therein, characterized in that said stimuable phosphor is a phosphor containing iodine and that said phosphor layer contains a compound having an epoxy group and/or at least one compound selected from the group consisting of phosphites, organotin compounds and metal salts of organic acids.

In the present specification, tin salts of organic acids are not included in the metal salts of organic acids.

In the present invention, the yellowing of a radiation image storage panel employing a stimuable phosphor containing iodine as a phosphor component is prevented and the sensitivity of the panel is remarkably enhanced, by incorporating into a phosphor layer thereof a compound having an epoxy group and/or at least one compound selected from the group consisting of phosphites, organotin compounds and metal salts of organic acids.

The present inventors have found that a phosphor layer tends to be colored yellow when an iodine-containing stimuable phosphor is used in a radiation image storage panel, and hence the light emitted by the phosphor, particularly the light in the blue region, is absorbed in the phosphor layer to extremely decrease the sensitivity of the panel. Such yellowing of the phosphor layer is caused by the phenomena that the iodine is liberated in the form of I_2 molecule from the phosphor in a coating dispersion for the preparation of the phosphor layer, and that the liberated iodine forms an I_2 molecule in the prepared phosphor layer, during the preparation of the panel.

In addition, the yellowing of the phosphor layer brings about damage to an external view of the radiation image storage panel to decrease a value thereof as a merchandize.

According to the invention, to a coating dispersion for the preparation of the phosphor layer is added a compound having an epoxy group and/or at least one compound selected from the group consisting of phosphites, organotin compounds and metal salts of organic acids, whereby iodine liberated from the stimuable phosphor is trapped by these compounds so as to prevent the formation of I_2 molecule. Iodine liberated from the phosphor in the prepared phosphor layer is also trapped by these compounds and free from the formation of I_2 molecule. In the case of the latter compounds, i.e., phosphites, organotin compounds and metal salts of organic acids, the reason is presumably that the compounds serve as a chelating agent for iodine to trap iodine effectively in a stable state. For instance, it is presumed that the liberated iodine atoms bind to tin in the organotin compound as a ligand to be in a prominently stable state. As a result, the phosphor layer is prevented from yellowing, and the radiation image storage panel having high sensitivity can be obtained. The panel can keep its value of merchandize, since the appearance thereof does not colored on standing.

Especially, a radiation image storage panel in which the phosphor layer contains not only the compound having an epoxy group but also the compound selected from the group consisting of phosphites, organotin compounds and metal salts of organic acids is effectively prevented from deterioration (decrease of sensitivity) with the passage of time and more enhanced in the sensitivity.

When an epoxy resin is used as the compound having an epoxy group, the epoxy resin also serves as a binder in the same place, so that adhesion strength between a support and the phosphor layer can be enhanced as well as the improvement in the sensitivity. It is included in the scope of the invention that all of the binder of the phosphor layer is an epoxy resin.

Further, the above-mentioned compounds may be incorporated in any parts (layers) other than the phosphor layer of the radiation image storage panel. The present inventors have found that the part close to the phosphor layer also tends to be colored yellow owing to the liberated I₂ molecule, which is produced for instance, by that a coating solution for the preparation of said part comes in contact with the iodine-containing stimuable phosphor, or that the part dissolved by the coating dispersion for the preparation of the phosphor layer comes in contact therewith. The light emitted by the stimuable phosphor is further absorbed by the yellowed part to decrease the sensitivity of the panel. Accordingly, it is desired that the part close to the phosphor layer also contains said compounds, for example, a light-reflecting layer, a subbing layer, a protective film, an adhesive agent or a polymer film for covering the side surfaces. The iodine liberated from the stimuable phosphor is efficiently trapped by said compounds in these parts and the formation of I₂ molecule does not occur, so that said parts can be prevented from yellowing.

Especially, the panel in which the phosphor layer and the part close thereto contains both of the epoxy group-containing compound and the compound selected from phosphites, organotin compounds and metal salts of organic acids can be much more enhanced in the sensitivity and reduce the deterioration with time. When an epoxy resin is used as the compound having an epoxy group, the epoxy resin also serves as a binder in the same place, so that adhesion strength between said part and the layer next thereto can be enhanced. It is included in the scope of the invention that whole the binder of said part is an epoxy resin.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a graph showing relationships between a thickness of the phosphor layer and a relative sensitivity, with respect to the radiation image storage panel containing a compound having an epoxy group according to the present invention (Curve 1) and a conventional radiation image storage panel (Curve 2).

Fig. 2 is a graph showing relationships between a thickness of the phosphor layer and a relative sensitivity, with respect to a radiation image storage panel containing a phosphite according to the present invention (Curve 1) and a conventional radiation image storage panel (Curve 2).

DETAILED DESCRIPTION OF THE INVENTION

The radiation image storage panel of the present invention having the above-described favorable characteristics can be prepared, for instance, in the following manner.

A support material employed in the invention can be selected from those employed in the conventional radiographic intensifying screens or those employed in the known radiation image storage panels. Examples of the support material include plastic films such as films of cellulose acetate, polyester, polyethylene terephthalate, polyamide, polyimide, triacetate and polycarbonate; metal sheets such as aluminum foil and aluminum alloy foil; ordinary papers; baryta paper; resin-coated papers; pigment papers containing titanium dioxide or the like; and papers sized with polyvinyl alcohol or the like. From the viewpoint of characteristics of a radiation image storage panel as an information recording material and handling thereof, a plastic film is preferably employed as the support material in the invention. The plastic film may contain a light-absorbing material such as carbon black, or may contain a light-reflecting material such as titanium dioxide. The former is appropriate for preparing a high-sharpness type radiation image storage panel, while the latter is appropriate for preparing a high-sensitivity type radiation image storage panel.

One or more additional layers may be occasionally provided between the support and the phosphor layer. For instance, a subbing layer may be provided to enhance the adhesion therebetween and a light-reflecting layer containing a light-reflecting material or a light-absorbing layer containing a light-absorbing material such as a carbon black may be provided to enhance the sensitivity or the image quality. Otherwise, an antistatic layer containing a conductive material such as carbon black, In_2O_3 and SnO_2 may be provided to enhance the antistatic property of the resulting panel.

The light-reflecting layer comprises a binder and a light-reflecting material dispersed therein.

Examples of the light-reflecting material include white pigments such as Al_2O_3 , ZrO_2 , TiO_2 , BaSO_4 , SiO_2 , ZnS , ZnO , MgO , CaCO_3 , Sb_2O_3 , Nb_2O_5 , $2\text{PbCO}_3 \cdot \text{Pb}(\text{OH})_2$, M<II>FX (in which M<II> is at least one element selected from the group of Ba, Sr and Ca; and X is at least one element selected from the group of Cl and Br), lithopone ($\text{BaSO}_4 + \text{ZnS}$), magnesium silicate, basic lead silicosulfate, basic lead phosphate and aluminum silicate; and polymer particles of hollow structure (polymer pigment).

The polymer particles of hollow structure comprise styrene polymer or styrene-acrylic copolymer and are fine particles, generally having an outer diameter ranging 0.2 - 1 μm and an inner diameter (diameter of hollow) ranging 0.05 - 0.7 μm . The employment of the hollow polymer particles as a light-reflecting material is described in detail in Japanese Patent Application No. 60(1985)-278665 (which corresponds to U.S. Patent application filed on December 11, 1986).

Among these light-reflecting materials, Al_2O_3 , ZrO_2 , TiO_2 , BaSO_4 , SiO_2 , ZnS , ZnO and M<II>FX (in which M<II> and X have the same definition as above) are preferably employed in the invention. The light-reflecting materials may be employed alone or in a combination thereof.

The light-reflecting layer can be formed on the support by the following procedure: The light-reflecting material and a binder are added to an appropriate solvent and they are mixed to prepare a coating dispersion comprising the material dispersed in the binder solution. The coating dispersion is uniformly applied onto the surface of the support to form a layer of the coating dispersion, which is subsequently heated to dryness to form a light-reflecting layer. The binder and solvent can be selected from binders and solvents employable in the preparation of a phosphor layer as mentioned below. In the case of the hollow polymer particles, aqueous polymer materials such as acrylic acid copolymers may be employed. The coating dispersion may further contain a dispersing agent, a plasticizer or a colorant.

The ratio between the binder and the light-reflecting material in the coating dispersion is within the range of from 1 : 1 to 1 : 50 (binder : material, by weight), preferably from 1 : 2 to 1 : 20, by weight. The thickness of the light-reflecting layer preferably ranges from 5 to 100 μm .

The light-reflecting layer may be formed on the support together with the phosphor layer by a simultaneous superposition-coating method.

The light-reflecting layer may contain a compound having an epoxy group and/or at least one compound selected from the group consisting of phosphites, organotin compounds and metal salts of organic acids by adding it to the coating dispersion, to prevent said layer from yellowing. The compound can be selected from compounds employable in a phosphor layer as described below, and may be the same or different from the compound contained therein. The amount of the compound contained in the light-reflecting layer varies depending on the kind and amount of the light-reflecting material and the kind of the binder. In the case of the former epoxy group-containing compound, the amount thereof is generally in the range of 0.001 to 10 % by weight of the light-reflecting material, preferably 0.03 to 3 % by weight and in the case of the latter compound, i.e., phosphite, organotin compound or metal salt of organic acid, the amount thereof is generally in the range of 0.0001 to 3 % by weight of the light-reflecting material, preferably 0.003 to 0.3 % by weight.

Iodine liberated from an iodine-containing stimutable phosphor in a phosphor layer is trapped by said compound, not forming I_2 molecule in the light-reflecting layer, and the light-reflecting layer is free from yellowing, so that the light-reflecting layer can sufficiently make an inherent function of reflecting the emitted light towards the phosphor layer (read-out side) to enhance the sensitivity of the resulting panel.

The subbing layer comprises a resin.

Examples of the resin include polyacrylic resins, polyester resins, polyurethane resins, polyvinyl acetate resins and ethylene-vinyl acetate copolymers. The resins employable in the subbing layer are not restricted to the above resins and any other resin (adhesive agent) conventionally employed for the preparation of the subbing layer can be employed in the invention. The resin of the subbing layer may be crosslinked with a crosslinking agent such as an aliphatic isocyanate, an aromatic isocyanate, melamine, an amino resin or a derivative of one of these compounds.

The subbing layer can be formed on the support by the following procedure: The resin are added to an appropriate solvent to prepare a coating solution. The solvent can be selected from solvents employable in the preparation of a phosphor layer as mentioned below. The coating solution is uniformly applied onto the surface of the support to form a layer of the coating solution. The coating procedure can be carried out by a conventional method such as a method using a doctor blade, a roll coater or a knife coater. Subsequently, the layer of the coating solution is heated slowly to dryness so as to complete the formation of a subbing layer.

The thickness of the subbing layer varies depending on the characteristics of the panel, the materials employed in the phosphor layer and the support, and the kinds of the resin, and generally ranges from 3 to 50 μm .

The subbing layer may also contain the compound for the prevention of yellowing by adding it to the coating solution. The compound can be selected from compounds employable in a phosphor layer as described below and may be the same or different from the compound contained therein. The amount of the compound contained in the subbing layer varies depending on the kind and amount of a stimutable phosphor and the kind of the resin. In the case of the epoxy group-containing compound, the amount thereof is generally in the range of 0.03 to 100 % by weight of the resin, preferably 1 to 30 % by weight and in the case of the phosphite, organotin compound or metal salt of organic acid, generally in the range of 0.003 to 30 % by weight of the resin, preferably 0.01 to 1 % by weight.

Iodine liberated from an iodine-containing stimutable phosphor in a phosphor layer is trapped by said compound, not forming I_2 molecule in the subbing layer, even when the dissolved subbing layer is in contact with the phosphor during the coating procedure for the preparation of a phosphor layer, so that the subbing layer is free from yellowing.

As described in Japanese Patent Provisional Publication No. 58(1983)-200200 (corresponding to U.S. Patent Application No. 496,278), the phosphor layer-side surface of the support (or the surface of a subbing layer, a light-reflecting layer, a light-absorbing layer or an antistatic layer in the case that such layers are provided on the support) may be provided with protruded and depressed portions for enhancement of the sharpness of the image.

On the support, a phosphor layer is formed.

The phosphor layer, that is a characteristic requisite of the invention, comprises a binder, a stimutable phosphor containing iodine, and a compound having an epoxy group and/or at least one compound selected from the group consisting of phosphites, organotin compounds and metal salts of organic acids, the latter two or three being dispersed in a binder.

The stimutable phosphor containing iodine which is employable in the invention contains iodine as a phosphor component. Namely, iodine is contained in the phosphor as at least one of a host component, an additive component and an activator component.

The stimutable phosphor containing iodine, as described hereinbefore, gives stimulated emission when excited with stimulating rays after exposure to a radiation. From the viewpoint of practical use, the stimutable phosphor is desired to give stimulated emission in the wavelength region of 300 - 500 nm when excited with stimulating rays in the wavelength region of 400 - 900 nm (e.g. a laser beam such as a He-Ne laser beam or a semiconductor laser beam).

Examples of the iodine-containing stimutable phosphor employable in the radiation image storage panel of the invention include:

(1) a rare earth element activated alkaline earth metal fluorohalide phosphor having the formula: $(\text{Ba}_{1-x}\text{M}_{2x})\text{FX}:\text{yA}$, in which M_{2x} is at least one divalent metal selected from the group consisting of

Mg, Ca, Sr, Zn and Cd; X is at least one element selected from the group consisting of Cl, Br and I; A is at least one element selected from the group consisting of Eu, Tb, Ce, Tm, Dy, Pr, Ho, Nd, Yb and Er; and x and y are numbers satisfying the conditions of $0 \leq x \leq 0.6$ and $0 \leq y \leq 0.2$, respectively, as described in U.S. Patent No. 4,239,968;

The phosphor may contain the following additives:

LiX' , BeX''^2 and $\text{M<III>X}'''^3$, in which each of X' , X'' and X''' is at least one element selected from the group consisting of Cl, Br and I; and M<III> is a trivalent metal, as described in Japanese Patent Provisional Publication No. 56(1981)-74175;

metal oxides such as BeO, MgO, CaO, SrO, BaO, ZnO, Al_2O_3 , Y_2O_3 , La_2O_3 , In_2O_3 , SiO_2 , TiO_2 , ZrO_2 , GeO_2 , SnO_2 , Nb_2O_5 , Ta_2O_5 and ThO_2 , as described in Japanese Patent Provisional Publication No. 55(1980)-160078;

Zr and Sc, as described in Japanese Patent Provisional Publication No. 56(1981)-116777;

B, as described in Japanese Patent Provisional Publication No. 57(1982)-23673;

As and Si, as described in Japanese Patent Provisional Publication No. 57(1982)-23675;

M.L, in which M is at least one alkali metal selected from the group consisting of Li, Na, K, Rb and Cs; and L is at least one trivalent metal selected from the group consisting of Sc, Y, La, Ce, Pr, Nd, Pm, Sm, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Al, Ga, In and Tl, as described in U.S. Patent Application No. 497,805;

fired products of tetrafluoroboric acid compounds, as described in U.S. Patent Application No. 520,215;

fired products of monovalent or divalent metal salts of hexafluoro silicic acid, hexafluoro titanate acid and hexafluoro zirconic acid, as described in U.S. Patent Application No. 502,648;

NaX' , in which X' is at least one element selected from the group consisting of Cl, Br and I, as described in Japanese Patent Provisional Publication No. 59(1984)-56479;

transition metals such as V, Cr, Mn, Fe, Co and Ni, as described in U.S. Patent Application No. 535,928;

$\text{M<I>X}'$, $\text{M'<II>X}''^2$, $\text{M<III>X}'''^3$ and A, in which M<I> is at least one alkali metal selected from the group consisting of Li, Na, K, Rb and Cs; M'<II> is at least one divalent metal selected from the group consisting of Be and Mg; M<III> is at least one trivalent metal selected from the group consisting of Al, Ga, In and Tl; A is metal oxide; and each of X' , X'' and X''' is at least one halogen selected from the group consisting of F, Cl, Br and I, as described in U.S. Patent Application No. 543,326;

$\text{M<I>X}'$, in which M<I> is at least one alkali metal selected from the group consisting of Rb and Cs; and X' is at least one halogen selected from the group consisting of F, Cl, Br and I, as described in as described in U.S. Patent Application No. 668,464;

$\text{M<II>X}''^2$, $\text{M<II>X}''^2$, in which M<II> is at least one alkaline earth metal selected from the group consisting of Ba, Sr and Ca; and each of X' and X'' is at least one halogen selected from the group consisting of Cl, Br and I, and $\text{X NOTEQUAL X}'$, as described in U.S. Patent Application No. 754,424; and

LnX''^3 , in which Ln is at least one rare earth element selected from the group consisting of Sc, Y, La, Ce, Pr, Nd, Pm, Sm, Gd, Tb, Dy, Ho, Er, Tm, Yb and Lu; and X'' is at least one halogen selected from the group consisting of F, Cl, Br and I, as described in Japanese Patent Application No. 60(1985)-106752;

(2) a divalent europium activated alkaline earth metal halide phosphor having the formula:

M<II>X_2 , aM<II>X_2 : xEu^{2+} , in which M<II> is at least one alkaline earth metal selected from the group consisting of Ba, Sr and Ca; each of X and X' is at least one halogen selected from the group consisting of Cl, Br and I, and $\text{X NOTEQUAL X}'$; and a and x are numbers satisfying the conditions of $0.1 \leq a \leq 10.0$ and $0 < x \leq 0.2$, respectively, as described in U.S. Patent Application No. 660,987;

The phosphor may contain the following additives:

$\text{M<I>X}''$, in which M<I> is at least one alkali metal selected from the group consisting of Rb and Cs; and X'' is at least one halogen selected from the group consisting of F, Cl, Br and I, as described in U.S. Patent Application No. 699,325;

KX'' , MgX'''^2 and $\text{M<III>X}'''^3$, in which M<III> is at least one trivalent metal selected from the group consisting of Sc, Y, La, Gd and Lu, and each of X'' , X''' and X''' is at least one halogen selected from the group consisting of F, Cl, Br and I, as described in U.S. Patent Application No. 723,819;

B, as described in U.S. Patent Application No. 727,974;

oxides such as SiO_2 and P_2O_5 , as described in U.S. Patent Application No. 727,972;

LiX'' and NaX'' , in which X'' is at least one halogen selected from the group consisting of F, Cl, Br and I, as described in U.S. Patent Application No. 797,972;

SiO , as described in U.S. Patent Application No. 797,971;

SnX''^2 , in which X'' is at least one halogen selected from the group consisting of F, Cl, Br, and I, as described in U.S. Patent Application No. 797,971;

CsX'' and SnX''^2 , in which each of X'' and X''' is at least one halogen selected from the group consisting of F, Cl, Br and I, as described in U.S. Patent Application No. 850,715; and

CsX'' and Ln^{3+} , in which X'' is at least one halogen selected from the group consisting of F, Cl, Br and I; and Ln is at least one rare earth element selected from the group consisting of Sc, Y, Ce, Pr, Nd, Sm, Gd,

Tb, Dy, Ho, Er, Tm, Yb and Lu, as described in U.S. Patent Application No. 850,715;

(3) a rare earth element activated rare earth oxyhalide phosphor having the formula: $\text{LnOX}:\text{xA}$, in which Ln is at least one element selected from the group consisting of La, Y, Gd and Lu; X is at least one element selected from the group consisting of Cl, Br and I; A is at least one element selected from the group consisting of Ce and Tb; and x is a number satisfying the condition of $0 < x < 0.1$, as described in U.S. Patent No. 4,236,078;

(4) a cerium activated trivalent metal oxyhalide phosphor having the formula: $\text{M<III>OX}:\text{xCe}$, in which M<III> is at least one trivalent metal selected from the group consisting of Pr, Nd, Pm, Sm, Eu, Tb, Dy, Ho, Er, Tm, Yb and Bi; X is at least one element selected from the group consisting of Cl, Br and I; and x is a number satisfying the condition of $0 < x < 0.1$, as described in Japanese Patent Provisional Publication No. 58(1983)-69281;

(5) a bismuth activated alkali metal halide phosphor having the formula: $\text{M<I>X}:\text{xBi}$, in which M<I> is at least one alkali metal selected from the group consisting of Rb and Cs; X is at least one halogen selected from the group consisting of Cl, Br and I; and x is a number satisfying the condition of $0 < x \leq 0.2$, as described in U.S. Patent Application No. 846,919;

(6) a divalent europium activated alkaline earth metal halophosphate phosphor having the formula: $\text{M<II>5(PO}_4\text{)}_3\text{X}:\text{xEu}^{2+}$, in which M<II> is at least one alkaline earth metal selected from the group consisting of Ca, Sr and Ba; X is at least one halogen selected from the group consisting of F, Cl, Br and I; and x is a number satisfying the condition of $0 < x \leq 0.2$, as described in U.S. Patent Application No. 681,131;

(7) a divalent europium activated alkaline earth metal haloborate phosphor having the formula: $\text{M<II>2.BO}_3\text{X}:\text{xEu}^{2+}$, in which M<II> is at least one alkaline earth metal selected from the group consisting of Ca, Sr and Ba; X is at least one halogen selected from the group consisting of Cl, Br and I; and x is a number satisfying the condition of $0 < x \leq 0.2$, as described in U.S. Patent Application No. 904,755;

(8) a divalent europium activated alkaline earth metal halophosphate phosphor having the formula: $\text{M<II>2.PO}_4\text{X}:\text{xEu}^{2+}$, in which M<II> is at least one alkaline earth metal selected from the group consisting of Ca, Sr and Ba; X is at least one halogen selected from the group consisting of Cl, Br and I; and x is a number satisfying the condition of $0 < x \leq 0.2$, as described in U.S. Patent Application No. 695,592;

(9) a divalent europium activated alkaline earth metal hydride halide phosphor having the formula: $\text{M<II>HX}:\text{xEu}^{2+}$, in which M<II> is at least one alkaline earth metal selected from the group consisting of Ca, Sr and Ba; X is at least one halogen selected from the group consisting of Cl, Br and I; and x is a number satisfying the condition of $0 < x \leq 0.2$, as described in U.S. Patent No. 4,605,861;

(10) a cerium activated rare earth complex halide phosphor having the formula: $\text{LnX}_3.\text{aLn}'\text{X}'_3:\text{xCe}^{3+}$, in which each of Ln and Ln' is at least one rare earth element selected from the group consisting of Y, La, Gd and Lu; each of X and X' is at least one halogen selected from the group consisting of F, Cl, Br and I, and $\text{X} \neq \text{X}'$; and a and x are numbers satisfying the conditions of $0 \leq a \leq 10.0$ and $0 < x \leq 0.2$, respectively, as described in U.S. Patent Application No. 752,539;

(11) a cerium activated rare earth halide phosphor having the formula: $\text{LnX}_3.\text{aM<I>X}'_3:\text{xCe}^{3+}$, in which Ln is at least one rare earth element selected from the group consisting of Y, La, Gd and Lu; M<I> is at least one alkali metal selected from the group consisting of Li, Na, K, Cs and Rb; each of X and X' is at least one halogen selected from the group consisting of Cl, Br and I; and a and x are numbers satisfying the conditions of $0 \leq a \leq 10.0$ and $0 < x \leq 0.2$, respectively, as described in U.S. Patent Application No. 753,541;

(12) a cerium activated rare earth halophosphate phosphor having the formula: $\text{LnPO}_4.\text{aLnX}_3:\text{xCe}^{3+}$, in which Ln is at least one rare earth element selected from the group consisting of Y, La, Gd and Lu; X is at least one halogen selected from the group consisting of F, Cl, Br and I; and a and x are numbers satisfying the conditions of $0 \leq a \leq 10.0$ and $0 < x \leq 0.2$, respectively, as described in U.S. Patent Application No. 760,035;

(13) a divalent europium activated cesium rubidium halide phosphor having the formula: $CsX.aRbX':xEu_{2-x}X_{1-x}$, in which each of X and X' is at least one halogen selected from the group consisting of Cl, Br and I; and a and x are numbers satisfying the conditions of $0 < a \leq 10.0$ and $0 < x \leq 0.2$, respectively, as described in U.S. Patent Application No. 850,609; and

(14) a divalent europium activated complex halide phosphor having the formula: $M_{1-x}X_2.aM_{1-x}X':xEu_{2-x}X_{1-x}$, in which M_{1-x} is at least one alkaline earth metal selected from the group consisting of Ba, Sr and Ca; M_{1-x} is at least one alkali metal selected from the group consisting of Li, Rb and Cs; each of X and X' is at least one halogen selected from the group consisting of Cl, Br and I; and a and x are numbers satisfying the conditions of $0.1 \leq a \leq 20.0$ and $0 < x \leq 0.2$, respectively, as described in U.S. Patent Application No. 850,689.

Among the above-described stimuable phosphors, the divalent europium activated alkaline earth metal fluorohalide phosphor containing iodine, divalent europium activated alkaline earth metal halide phosphor containing iodine, rare earth element activated rare earth oxyhalide phosphor containing iodine and bismuth activated alkali metal halide phosphor containing iodine are particularly preferred, because these phosphors show stimulated emission of high luminance. The above-described stimuable phosphors are given by no means to restrict the iodine-containing stimuable phosphor employable in the present invention. Any other phosphors can be also employed, provided that the phosphor contains iodine as a phosphor component and gives stimulated emission when excited with stimulating rays after exposure to a radiation.

The compound having an epoxy group employable in the invention has at least one epoxy group EMI19.1 in a molecule.

The epoxy group-containing compound may be a monomer or a polymer. Examples of the monomer include 1,2-epoxypropane and 1,2-epoxybutane. Examples of the polymer include a bisphenol A-type epoxy resin having the formula: EMI19.2

The epoxy group-containing compound is preferably a polymer, because the compound serves not only as an additive for the prevention of yellowing but also as a binder. Whole the binder may be the epoxy group-containing compound.

Representative examples of the phosphite (phosphorus chelate) employable in the invention include a compound having the formula (I) and a compound having the formula (II): EMI20.1 in which A is an oxygen atom or a sulfur atom; each of R_{1-4} is a hydrogen atom, an alkyl group or an aryl group, and R_1, R_2, R_3 and R_4 are the same or different from each other; and X_{1-4} is a group comprising a carbon atom and/or an oxygen atom and/or a hydrogen atom.

Examples of the preferred phosphite include:

- (1) triphenyl phosphite: EMI20.2
- (2) diphenyldecyl phosphite: EMI20.3
- (3) didecylphenyl phosphite: EMI20.4
- (4) tridecyl phosphite: $(C_{10}H_{21}O)_3P$
- (5) trioctyl phosphite: $(C_8H_{17}O)_3P$
- (6) tridodecyl phosphite: $(C_{12}H_{25}O)_3P$
- (7) trioctadecyl phosphite: $(C_{18}H_{37}O)_3P$
- (8) trinonylphenyl phosphite: EMI20.5
- (9) tridodecyltrithio phosphite: $(C_{12}H_{25}S)_3P$

The above-mentioned compounds having the formula (I) and the formula (II) may be employed singly or in combination.

Examples of the organotin compound employable in the invention include a compound having the formula (III): EMI21.1 in which each of R_{5-6} is a hydrogen atom, an alkyl group or an aryl group, and R_5 and R_6 are the same or different from each other; each of Y_{1-4} , Y_2 , Y_3 and Y_4 is an alkyl group, an aryl group, a fatty acid, a fatty acid derivative, mercaptan or a mercaptan carboxylic acid, and Y_1, Y_2, Y_3 and Y_4 are the same or different from each other; X_2 is an oxygen atom, a sulfur atom or a maleic acid; and n is 0 or an integer of not less than 1.

The organotin compound is liable to be relatively stabilized in such a state that a portion of organic ligands

bound to tin substituted by halogen, etc. In the formula (III), at least one ligand of Y<1> to Y<4> is substituted by iodine to make the compound stable.

Examples of the preferred organotin compound include dioctyltin mercaptide, monobutyltin trimethylmaleate, monobutyltin trioctylmaleate, dibutyltin dilaurate, dibutyltin laurate methylmaleate, dibutyltin dioleilmaleate, dibutyltin dimethylmaleate, dibutyltin maleate, dibutyltin methoxymethylmaleate, a mixture of dibutyltin dimaleate and dibutyltin dimethylmaleate, dibutyltin dioctylmaleate, dibutyltin dioctylthioglycolate, dibutyltin dilaurylmercaptide, tribenzyltin octylmaleate and tribenzyltin trimethylmaleate.

Examples of the metal salt of organic acid employable in the invention include a compound having the formula (IV):

$(R<7>COO)mM$ (IV)

in which R<7> is an alkyl group or an aryl group having 1 - 20 carbon atoms, which may have at least one substituent; M is calcium, zinc, cadmium or barium; and m is a positive integer.

It is presumed that a portion of organic acids in the metal salt of organic acid having the formula (IV), is substituted by iodine to form $(R<7>COO)m-1MI$. A tin salt of organic acid is not included in the metal salt of organic acid employable in the invention.

Examples of the organic acid in the metal salt of organic acid include octylic acid, lauric acid, stearic acid, oleic acid, ricinoleic acid, naphthenic acid, 2-ethylhexanoic acid, resin acid, synthetic carboxylic acid, benzoic acid, salicylic acid and organic phosphinous acid. The organic acid may be phenol or alkylphenol.

Examples of the metal salt of organic acid include so-called metallic soap such as barium stearate, barium laurate, barium ricinoleate, barium naphthenate, barium 2-ethylhexanoate, calcium stearate, calcium laurate, calcium ricinoleate, zinc stearate, zinc laurate, zinc ricinoleate and zinc 2-ethylhexanoate.

These phosphites, organotin compounds and metal salts of organic acids can be employed singly or in combination of two or more compounds.

The above-mentioned epoxy group-containing compound and at least one of the compound selected from the group consisting of phosphites, organotin compounds and metal salts of organic acids may be incorporated singly into the phosphor layer. Otherwise, both of the compounds may be appropriately incorporated into the phosphor layer.

The iodine liberated from the stimuable phosphor can be effectively trapped by these compounds, I₂ molecules are not produced and hence, the phosphor layer is free from yellowing.

Examples of the binder to be contained in the phosphor layer include: natural polymers such as proteins (e.g. gelatin), polysaccharides (e.g. dextran) and gum arabic; and synthetic polymers such as polyvinyl butyral, polyvinyl acetate, nitrocellulose, ethylcellulose, vinylidene chloride-vinyl chloride copolymer, polyalkyl (meth)acrylate, vinyl chloride-vinyl acetate copolymer, polyurethane, cellulose acetate butyrate, polyvinyl alcohol, and linear polyester. Particularly preferred are nitrocellulose, linear polyester, polyalkyl (meth)acrylate, a mixture of nitrocellulose and linear polyester, and a mixture of nitrocellulose and polyalkyl (meth)acrylate. These binders may be crosslinked with a crosslinking agent.

The phosphor layer can be formed on the support, for instance, by the following procedure.

In the first place, the above-described stimuable phosphor containing iodine, compound for the prevention of yellowing and binder are added to an appropriate solvent, and then they are well mixed to prepare a coating dispersion comprising the phosphor particles and the compound homogeneously dispersed in the binder solution.

Examples of the solvent employable in the preparation of the coating dispersion include lower alcohols such as methanol, ethanol, 1-propanol, 2-propanol and n-butanol; chlorinated hydrocarbons such as methylene chloride and ethylene chloride; ketones such as acetone, methyl ethyl ketone and methyl isobutyl ketone; esters of lower alcohols with lower aliphatic acids such as methyl acetate, ethyl acetate and butyl acetate; ethers such as dioxane, ethylene glycol monoethylether and ethylene glycol monomethyl ether; and mixtures of the above-mentioned compounds.

The ratio between the binder and the stimuable phosphor in the coating dispersion (the ratio between the epoxy group-containing compound and the phosphor in the case of whole the binder being said compound) may be determined according to the characteristics of the aimed radiation image storage panel, the nature of the phosphor employed, and the amount of the epoxy group-containing compound. Generally, the ratio therebetween is within the range of from 1 : 1 to 1 : 100 (binder : phosphor, by weight), preferably from 1 : 8 to 1 : 40.

The amount of the compound having an epoxy group varies depending upon the nature and amount of the employed stimuable phosphor, the kind of the binder, etc., and the amount thereof is generally in the range of 0.001 to 10 % by weight, preferably 0.03 to 3 % by weight, of the stimuable phosphor. When the amount is less than 0.001 % by weight, there can be hardly obtained the yellowing-preventing effect. When the amount exceeds 10 % by weight, even if whole the binder is the epoxy group-containing compound, unfavorable effects are given to the emission characteristics of the phosphor or various properties of the resulting panel such as flexibility and endurance, although the yellowing-preventing effect can be obtained.

The amount of the phosphite, organotin compound and/or metal salt of organic acid also varies depending upon the nature and amount of the employed stimuable phosphor, the kind of the binder, etc., and generally is in the range of 0.0001 to 3 % by weight, preferably in the range of 0.003 to 0.3 % by weight, of the stimuable phosphor.

The coating dispersion may contain a dispersing agent to improve the dispersibility of the phosphor particles therein, and may contain a variety of additives such as a plasticizer for increasing the bonding between the binder and the phosphor particles in the phosphor layer. Examples of the dispersing agent include phthalic acid, stearic acid, caproic acid and a hydrophobic surface active agent. Examples of the plasticizer include phosphates such as triphenyl phosphate, tricresyl phosphate and diphenyl phosphate; phthalates such as diethyl phthalate and dimethoxyethyl phthalate; glycolates such as ethylphthalyl ethyl glycolate and butylphthalyl butyl glycolate; and polyesters of polyethylene glycols with aliphatic dicarboxylic acids such as polyester of triethylene glycol with adipic acid and polyester of diethylene glycol with succinic acid.

The coating dispersion prepared as described above is applied evenly onto the surface of the support to form a layer of the coating dispersion. The coating procedure can be carried out by a conventional method such as a method using a doctor blade, a roll coater or a knife coater. After applying the coating dispersion onto the support, the coating dispersion is then heated slowly to dryness so as to complete the formation of a phosphor layer. The thickness of the phosphor layer varies depending upon the characteristics of the aimed radiation image storage panel, the nature of the phosphor, the ratio between the binder and the phosphor, etc. Generally, the thickness of the phosphor layer is within the range of from 20 μm to 1 mm, and preferably from 50 to 500 μm .

The phosphor layer can be provided onto the support by the methods other than that given in the above. For instance, the phosphor layer is initially prepared on a sheet (false support) such as a glass plate, metal plate or plastic sheet using the aforementioned coating dispersion and then thus prepared phosphor layer is superposed on the genuine support by pressing or using an adhesive agent.

On the surface of the phosphor layer not facing the support, a transparent protective film may be provided to protect the phosphor layer from physical and chemical deterioration.

The protective film can be provided onto the phosphor layer by coating the surface of the phosphor layer with a solution of a transparent polymer such as a cellulose derivative (e.g. cellulose acetate or nitrocellulose), or a synthetic polymer (e.g. polymethyl methacrylate, polyvinyl butyral, polyvinyl formal, polycarbonate, polyvinyl acetate, or vinyl chloride-vinyl acetate copolymer), and drying the coated solution.

Otherwise, the transparent film can be provided onto the phosphor layer by beforehand preparing it from a polymer such as polyethylene terephthalate, polyethylene, polyvinylidene chloride or polyamide, followed by placing and fixing (laminating) it onto the phosphor layer with an appropriate adhesive agent. The transparent film can be prepared by coating a sheet such as a glass plate, metal plate or plastic sheet with a solution of the polymer and drying. Examples of the adhesive agent include a polyacrylic resin, a polyester resin, a polyurethane resin, a polyvinyl acetate resin and ethylene-vinyl acetate copolymers. The adhesive agent is by no means restricted to these resins, and for instance, other known resins which are

conventionally used as an adhesive agent can be employed. The adhesive agent is used as a solution prepared by adding it to an appropriate solvent. The solvents employable in the solution of the polymer and in the solution of the adhesive agent can be selected from the aforementioned solvents.

The transparent protective film preferably has a thickness in the range of approximately 0.1 to 20 μm . In the case of using the adhesive agent, the thickness of the adhesive layer is generally in the range of 0.1 to 10 μm .

Alternatively, the protective film may be formed together with the phosphor layer by a simultaneous superposition-coating method. The coating dispersion for the phosphor layer and the coating solution for the protective film are evenly applied onto the surface of the support in simultaneous stage and in the superposed form, in such a manner that the coating dispersion is arranged on the support side, to form superposed layers of the coating dispersion and the coating solution, followed by heating to dryness. The applying procedure is conducted by using a two-hopper type coating apparatus, etc. Otherwise, after the coating dispersion for the phosphor layer is applied onto the support, the coating solution for the protective film is immediately applied onto the layer of the coating dispersion, and then both the coated layers are heated to dryness to form the phosphor layer and the protective film simultaneously.

The binder in the coating dispersion for the phosphor layer and the polymer in the coating solution for the protective film may be compatible or incompatible with each other. In the case of compatible ones, there is not an interface between the resulting phosphor layer and protective film, that is, a single layer comprising a part containing the stimutable phosphor and another part substantially not containing it. The solvents in both the coating dispersion and the coating solution may be the same or different from each other, and the solvents miscible with each other are preferable from the viewpoint of drying the coated layers at the same speed. The ratio between the amount of the coating dispersion and the amount of the coating solution varies depending on the viscosity thereof, the ratio between the binder and the phosphor, etc, and generally is within the range of from 100 : 1 to 1 : 1, in volume, preferably from 10 : 1 to 1 : 1. Examples of the polymer material employable in the coating solution for the protective film further include melamine and a phenol resin.

The protective film may also contain the compound for the prevention of yellowing by adding it to the solution of the polymer. The compound can be selected from the above-mentioned compounds employable in the phosphor layer and may be the same or different from the compound contained therein. The amount of the compound contained in the protective film varies depending on the nature and amount of the stimutable phosphor, the kind of the polymer, etc. In the case of the epoxy group-containing compound, the amount thereof is generally in the range of 0.03 to 100 % by weight of the polymer, preferably 1 to 30 % by weight and in the case of the phosphite, organotin compound or metal salt of organic acid, generally in the range of 0.003 to 30 % by weight of the polymer, preferably 0.01 to 1 % by weight.

Iodine liberated from the iodine-containing stimutable phosphor in the phosphor layer is trapped by said compound, not forming I_2 molecule in the protective film, even when the solution of the polymer is contact with the phosphor during the coating procedure for the preparation of the protective film, so that the protective film is free from yellowing.

When the protective film is formed by the lamination method, the adhesive layer may contain the compound for the prevention of yellowing by adding it to the solution of the adhesive agent. The compound can be selected from the above-mentioned compounds employable in the phosphor layer and may be the same or different from the compound contained therein. The amount of the compound contained in the adhesive layer varies depending on the nature and amount of the stimutable phosphor, the kind of the adhesive agent, etc. In the case of the epoxy group-containing compound, the amount thereof is generally in the range of 0.03 to 100 % by weight of the adhesive agent, preferably 1 to 30 % by weight and in the case of the phosphite, organotin compound or metal salt of organic acid, generally in the range of 0.003 to 30 % by weight of the adhesive agent, preferably 0.01 to 1 % by weight.

Iodine liberated from the iodine-containing stimutable phosphor in the phosphor layer is trapped by said compound, not forming I_2 molecule in the adhesive layer, even when the softened adhesive agent is contact with the phosphor during the lamination procedure with heating or under severe conditions of a temperature and a humidity, so that the adhesive layer is free from yellowing.

The radiation image storage panel of the invention may be colored with a colorant to enhance the

sharpness of the resulting image, as described in U.S. Patent No. 4,394,581 and U.S. Patent Application No. 326,642. For the same purpose, the radiation image storage panel of the invention may contain a white powder in the phosphor layer, as described in U.S. Patent No. 4,350,893.

The radiation image storage panel may be covered on the side surfaces thereof with a polymer material to improve the mechanical strength such as the resistance to shock and the resistance to bending.

In the present specification, the term "side surfaces" includes those at the front and back of the panel and those at both the sides thereof, viewed along the direction in which the panel is transferred. The term "covering the side surfaces of the panel" means that one or more side surfaces (opportunately, all the side surfaces) of the panel are covered.

As for the the polymer material, polymers generally known as a covering material can be employed. Examples of the polymer material include polyurethane, an acrylic resin, a mixture of polyurethane and/or an acrylic resin with other polymers (polymers for blend) such as a vinyl chloride-vinyl acetate copolymer, as described in U.S. Patent Application No. 434,885; a linear polyester and a mixture of a linear polyester and a vinyl chloride-vinyl acetate copolymer, as described in U.S. Patent Application No. 878,273.

The linear polyester is, for example, a polycondensation reaction product of dibasic acid with dioxy compound or a polycondensation reaction product of oxy acid. Examples of the dibasic acid include succinic acid, glutaric acid, adipic acid, terephthalic acid and iso phthalic acid. Examples of the dioxy compound include ethylene glycol, 1,3-propanediol, 1,4-butanediol and 1,4-cyclohexane dimethanol. Examples of the oxy acid glycolic acid, lactic acid, malic acid, tartaric acid, citric acid, salicylic acid, benzoic acid, gallic acid, mandelic acid and tropic acid. The average molecular weight of the linear polyester is preferably in the range of 13,000 to 22,000.

In a vinyl chloride-vinyl acetate copolymer, the ratio therebetween is decided considering the physical properties such as adhesion and rigidity. The preferred ratio therebetween is in the range of 75 : 25 to 97 : 3 (vinyl chloride : vinyl acetate, by weight). The molecular weight of the vinyl chloride-vinyl acetate copolymer is preferably in the range of 10,000 to 25,000.

The mixture ratio between the linear polyester and the vinyl chloride-vinyl acetate copolymer varies depending upon the facilitation of transfer of the panel in the transfer system. The preferred mixing ratio is in the range of 9 : 1 to 4 : 6 (linear polyester : vinyl chloride-vinyl acetate copolymer, by weight).

The covering is carried out by dissolving the above-mentioned polymer in an appropriate solvent to prepare a solution (covering solution) of the polymer and then, coating the side surfaces of the panel therewith followed by drying. The solvents can be selected from the aforementioned solvents employable in the phosphor layer. The coating procedure can be done by a conventional method such as a spray coating method or a method using a doctor blade, a roll coater or a knife coater. Otherwise, the covering may be carried out by beforehand forming the longitudinal thin film (tape) and fixing the tape on the side surfaces of the panel with an adhesive agent.

The thickness of the polymer film varies depending upon the transferability of the resulting panel and the degree of wastage of the polymer film in the transfer system. Generally, the thickness of the polymer film is in the range of 2 to 100 μm , and preferably 10 to 50 μm .

The polymer film for covering may also contain the compound for the prevention of yellowing by adding to the solution of the polymer. The compound can be selected from the aforementioned compounds employable in the phosphor layer and may be the same or different from the compound contained therein. Among said compounds, the compound having an epoxy group is preferred and more preferred is the bisphenol A-type epoxy resin. The amount of the compound contained in the polymer film varies depending on the nature and amount of the stimuable phosphor and the kind of the polymer. In the case of the epoxy group-containing compound, the amount thereof is generally in the range of 0.1 to 100 % by weight of the polymer, preferably 5 to 100 % by weight and in the case of the phosphite, organotin compound or metal salt of organic acid, generally in the range of 0.01 to 10 % by weight of the polymer, preferably 0.1 to 5 % by weight.

Iodine liberated from the stimuable phosphor in the phosphor layer is trapped by said compound, not forming I₂ molecule in the polymer film, even when the solution of the polymer is in contact with the phosphor during the coating procedure for the covering, so that the polymer film is free from yellowing.

Thus, the incorporation of the compound for the prevention of yellowing into each part (layer) of the panel can prevent the panel from being colored yellow.

For further improvement in the transferability and the resistance to damage of the panel, the panel may be chamfered on the edges thereof and then covered on the side surfaces thereof including the chamfered edge with the polymer material.

The chamfering can be carried out in the manner as described in the aforementioned U.S. Patent Application No. 496,731. The chamfering is preferably applied to the front edge of the panel (viewed along the transfer direction thereof) on the support side for facilitating transfer of the panel. It is more preferable to chamfer all edges of the panel on the support side for preventing the front surface of the panel (the phosphor layer-side surface of the protective film-side surface) from damage. It is further preferable to chamfer the edges on the phosphor layer-side as well as on the support side, so as to more improve both the transferability and the resistance to damage of the panel. The so chamfered edge may have a flat face or a curved face.

The chamfering of the edge on the support side of the panel should be preferably done in a depth within the range of 1/50 to 1/1 against the thickness of the support, measured in the direction vertical to the panel. Likewise, the chamfering of the edge on the phosphor layer-side (including a protective film when the protective film is provided thereon) of the panel should be preferably done in a depth within the range of 1/50 to 1/1 against the thickness of the phosphor layer. When the edge on the support side and the edge on the phosphor layer-side opposite to said edge are to be chamfered, the depth of at least one chamfered space is preferably adjusted to a level of less than 1/1 (against the same as above) so that the side chamfered at its both edges might not form a sharp edge.

The following examples further illustrate the present invention, but these examples are understood to by no means restrict the invention.

Example 1

To 18 g. of methyl ethyl ketone were added 120 g. of a particulate divalent europium activated barium fluorobromide ($\text{BaFBr}0.85\text{I}0.15:0.001\text{Eu}^{2+}$) stimuable phosphor, 24 g. of a methyl ethyl ketone solution of acrylic resin (solid content: 10 wt.%), 6 g. of a methyl ethyl ketone solution of nitrocellulose (solid content: 10 wt.%) and 2 g. of a methyl ethyl ketone solution of bisphenol A-type epoxy resin having an average molecular weight of 900 (solid content: 50 wt.%). The mixture was sufficiently stirred by means of a propeller agitator to obtain a homogeneous coating dispersion having a mixing ratio of 1 : 40 (binder : phosphor, by weight) and a viscosity of 25 - 30 PS (at 25 DEG C).

The coating dispersion was applied evenly onto a polyethylene terephthalate sheet containing carbon black (support, thickness: 250 μm) placed horizontally on a glass plate. The application of the coating dispersion was carried out using a doctor blade with varying a diameter of the aperture of the doctor blade. After the coating was complete, the support having a layer of the coating dispersion was placed in an oven and heated at a temperature gradually rising from 25 to 100 DEG C. Thus, a phosphor layer having various thickness in the range of 150 to 500 μm was formed on the support.

On the phosphor layer was placed a transparent polyethylene terephthalate film (thickness: 12 μm ; provided with a polyester adhesive layer on one surface) to combine the transparent film and the phosphor layer with the adhesive layer.

Thus, a radiation image storage panel consisting essentially of a support, a phosphor layer and a transparent protective film was prepared.

Comparison Example 1

The procedure of Example 1 was repeated except for not using the bisphenol A-type epoxy resin solution and using 20 g. of methyl ethyl ketone in the preparation of the coating dispersion, to prepare a radiation image storage panel consisting essentially of a support, a phosphor layer and a transparent protective film.

The radiation image storage panels obtained in Example 1 and Comparison Example 1 were exposed to X-rays at 80 KVP and then excited with a He-Ne laser beam (wavelength: 632.8 nm) to measure the sensitivity. The results are shown in Fig. 1.

Fig. 1 is a graph in which the thickness of the phosphor layer is plotted on the abscissa and the relative sensitivity is plotted on the ordinate. In Fig. 1,

Curve 1: panel containing epoxy group-containing compound (Example 1), and

Curve 2: panel not containing epoxy group-containing compound (Comparison Example 1).

As is evident from Fig. 1, the radiation image storage panel wherein the epoxy-group containing compound is contained in the phosphor layer according to the invention (Example 1) was remarkably improved in the sensitivity, as compared with the known radiation image storage panel not containing the epoxy-group containing compound (Comparison Example 1). The phosphor layer of the known panel extremely yellowed, and the sensitivity was enhanced only a little even when the thickness thereof was made larger. On the contrary, no yellowing was shown in the phosphor layer of the panel of the invention, and the sensitivity increased in proportion to the thickness thereof.

Example 2

The procedure of Example 1 was repeated except for using 120 g. of a particulate bismuth activated cesium iodide (CsI:0.001Bi) phosphor as a stimuable phosphor and using 1 g. of 1,2-epoxypropane instead of the bisphenol A-type epoxy resin solution, to form a phosphor layer having a thickness of 250 μm on the support.

On the phosphor layer was formed a transparent protective film in the same manner as described in Example 1, to prepare a radiation image storage panel consisting essentially of a support, a phosphor layer and a transparent protective film.

Comparison Example 2

The procedure of Example 2 was repeated except for not adding 1,2-epoxypropane to the coating dispersion, to prepare a radiation image storage panel consisting essentially of a support, a phosphor layer and a transparent protective film.

The radiation image storage panels obtained in Example 2 and Comparison Example 2 were measured on the sensitivity in the same manner as described above. The results are set forth in Table 1. The sensitivity of the panel was expressed by a relative value on the basis of that of Example 2 being 100. EMI36.1

Example 3

The procedure of Example 1 was repeated except for using 120 g. of a particulate divalent europium activated barium chlorobromide ($\text{BaCl} \cdot \text{Br} \cdot 0.910.1:0.001\text{Eu}^{2+}$) phosphor as a stimuable phosphor and using 1 g. of 1,2-epoxybutane instead of the bisphenol A-type epoxy resin solution, to form a phosphor layer having a thickness of 250 μm on the support.

On the phosphor layer was formed a transparent protective film in the same manner as described in Example 1, to prepare a radiation image storage panel consisting essentially of a support, a phosphor layer and a transparent protective film.

Comparison Example 3

The procedure of Example 3 was repeated except for not adding 1,2-epoxybutane to the coating dispersion, to prepare a radiation image storage panel consisting essentially of a support, a phosphor layer and a transparent protective film.

The radiation image storage panels obtained in Example 3 and Comparison Example 3 were exposed to

X-rays at 80 KVp, and then excited with a semiconductor laser beam (wavelength: 780 nm), to measure the sensitivity. The results are set forth in Table 2, The sensitivity of the panel was expressed by a relative value on the basis of that of Example 3 being 100. EMI37.1

Example 4

To 18 g. of methyl ethyl ketone were added 120 g. of a particulate divalent europium activated barium fluorobromide ($\text{BaFBr}0.85\text{I}0.15:0.001\text{Eu}^{2+}$) stimuable phosphor, 24 g. of a methyl ethyl ketone solution of acrylic resin (solid content: 10 wt.%), 6 g. of a methyl ethyl ketone solution of nitrocellulose (solid content: 10 wt.%) and 0.04 g. of a methyl ethyl ketone solution of diphenyldecyl phosphite having an average molecular weight of 374 (solid content: 50 wt.%). The mixture was sufficiently stirred by means of a propeller agitator to obtain a homogeneous coating dispersion having a mixing ratio of 1 : 40 (binder : phosphor, by weight) and a viscosity of 25 - 30 PS (at 25 DEG C).

The coating dispersion was applied evenly onto a polyethylene terephthalate sheet containing carbon black (support, thickness: 250 μm) placed horizontally on a glass plate. The application of the coating dispersion was carried out using a doctor blade with varying a diameter of the aperture of the doctor blade. After the coating was complete, the support having a layer of the coating dispersion was placed in an oven and heated at a temperature gradually rising from 25 to 100 DEG C. Thus, a phosphor layer having various thickness in the range of 200 to 500 μm was formed on the support.

On the phosphor layer was placed a transparent polyethylene terephthalate film (thickness: 12 μm ; provided with a polyester adhesive layer on one surface) to combine the transparent film and the phosphor layer with the adhesive layer.

Thus, a radiation image storage panel consisting essentially of a support, a phosphor layer and a transparent protective film was prepared.

Comparison Example 4

The procedure of Example 4 was repeated except for not using the diphenyldecyl phosphite solution and using 20 g. of methyl ethyl ketone in the preparation of the coating dispersion, to prepare a radiation image storage panel consisting essentially of a support, a phosphor layer and a transparent protective film.

The radiation image storage panels obtained in Example 4 and Comparison Example 4 were measured on the sensitivity in the same manner as described hereinbefore. The results are shown in Fig. 2.

Fig. 2 is a graph in which the thickness of the phosphor layer is plotted on the abscissa and the relative sensitivity is plotted on the ordinate. In Fig. 2,

Curve 1: panel containing phosphite (Examples 4), and

Curve 2: panel not containing phosphite (Comparison Example 4).

As is evident from Fig. 2, the radiation image storage panel wherein phosphite is contained in the phosphor layer according to the invention (Example 4) was remarkably improved in the sensitivity, as compared with the known radiation image storage panel not containing phosphite (Comparison Example 4). The phosphor layer of the known panel extremely yellowed, and the sensitivity was enhanced only a little even when the thickness thereof was made larger. On the contrary, no yellowing was shown in the phosphor layer of the panel of the invention, and the sensitivity increased in proportion to the thickness thereof.

Example 5

The procedure of Example 4 was repeated except for using 120 g. of a particulate bismuth activated cesium iodide ($\text{CsI}:0.001\text{Bi}$) phosphor as a stimuable phosphor and using 0.04 g. of dioctyltin mercaptide instead of the diphenyldecyl phosphite, to form a phosphor layer having a thickness of 250 μm on the support.

On the phosphor layer was formed a transparent protective film in the same manner as described in Example 4, to prepare a radiation image storage panel consisting essentially of a support, a phosphor layer and a transparent protective film.

Comparison Example 5

The procedure of Example 5 was repeated except for not adding dioctyltin mercapto to the coating dispersion, to prepare a radiation image storage panel consisting essentially of a support, a phosphor layer and a transparent protective film.

The radiation image storage panels obtained in Example 5 and Comparison Example 5 were measured on the sensitivity in the same manner as described above. The results are set forth in Table 3. The sensitivity of the panel was expressed by a relative value on the basis of that of Example 5 being 100. EMI40.1

Example 6

The procedure of Example 4 was repeated except for using 120 g. of a particulate divalent europium activated barium chlorobromide ($\text{BaCl} \cdot \text{Br} \cdot 0.910.1:0.001\text{Eu}^{2+}$) phosphor as a stimuable phosphor and using 0.02 g. of barium stearate and 0.02 g. of zinc stearate instead of diphenyldecyl phosphite, to form a phosphor layer having a thickness of 250 μm on the support.

On the phosphor layer was formed a transparent protective film in the same manner as described in Example 4, to prepare a radiation image storage panel consisting essentially of a support, a phosphor layer and a transparent protective film.

Comparison Example 6

The procedure of Example 6 was repeated except for not adding barium stearate and zinc stearate to the coating dispersion, to prepare a radiation image storage panel consisting essentially of a support, a phosphor layer and a transparent protective film.

The radiation image storage panels obtained in Example 6 and Comparison Example 6 were exposed to X-rays at 80 KVp, and then excited with a semiconductor laser beam (wavelength: 780 nm), to measure the sensitivity. The results are set forth in Table 4. The sensitivity of the panel was expressed by a relative value on the basis of that of Example 6 being 100. EMI41.1

Example 7

The procedure of Example 4 was repeated except for further adding 2 g. of a methyl ethyl keton solution of bisphenol A-type epoxy resin having an average molecular weight of 900 (solid content: 50 wt.%) to the coating dispersion, to form a phosphor layer having a thickness of 400 μm on the support.

On the phosphor layer was formed a transparent protective film in the same manner as described in Example 4, to prepare a radiation image storage panel consisting essentially of a support, a phosphor layer and a transparent protective film.

The radiation image storage panels obtained in Example 7 as well as Examples 1 and 4 were evaluated on the deterioration characteristics according to the following test.

The panel was measured on the sensitivity in the same manner as described above. After the panel was allowed to stand at a temperature of 60 DEG C and at a humidity of 80 %RH for 7 days, the panel was again measured on the sensitivity.

The results are set forth in Table 5. The sensitivity of each panel was expressed by a relative value on the basis of that of each panel before the standing being 100. EMI42.1

As is evident from Table 5, the radiation image storage panel wherein both of phosphite and epoxy group-

containing compound were contained in the phosphor layer according to the invention (Example 7) kept higher sensitivity than the radiation image storage panel containing only the epoxy group-containing compound (Example 1) and than the radiation image storage panel containing only the phosphite (Example 4).

Example 8

To 300 g. of zirconium oxide (white pigment) were added 105 g. of a linear polyester resin, 300 g. of a methyl ethyl ketone solution of nitrocellulose having a nitration degree of 11.5 % (solid content: 10 wt.%), 15 g. of a bisphenol A-type epoxy resin having an average molecular weight of 800 and further methyl ethyl ketone. The mixture was sufficiently stirred by means of a propeller agitator to obtain a homogeneous dispersion of white pigment (coating dispersion I) having a mixing ratio of 1 : 2 (binder containing epoxy resin : white pigment, by weight) and a viscosity of 25 - 35 PS (at 25 DEG C).

To 300 g. of a particulate divalent europium activated barium fluorobromide ($\text{BaFBr}0.85\text{I}0.15:0.001\text{Eu}^{2+}$) stimuable phosphor were added 10.5 g. of the linear polyester resin, 30 g. of the nitrocellulose solution (solid content: 10 wt.%), 6 g. of a methyl ethyl ketone solution of nitrocellulose (solid content: 10 wt.%), 1.5 g. of a bisphenol A-type epoxy resin having an average molecular weight of 500 and further methyl ethyl ketone. The mixture was sufficiently stirred by means of a propeller agitator to obtain a homogeneous dispersion of phosphor (coating dispersion II) having a mixing ratio of 1 : 20 (binder : phosphor, by weight) and a viscosity of 25 - 35 PS (at 25 DEG C).

The coating dispersion I was initially applied evenly onto a polyethylene terephthalate sheet containing carbon black (support, thickness: 250 μm) placed horizontally on a glass plate by using a doctor blade. Immediately, the coating dispersion II was applied onto a layer of the coating dispersion I in the same manner as quickly as the solvent of the coating dispersion I was not removed. After the coating was complete, the support having superposed layers of the coating dispersions I and II was placed in an oven and heated at a temperature gradually rising from 25 to 100 DEG C, to simultaneously form a light-reflecting layer having a thickness of 30 μm and a phosphor layer having a thickness of 250 on the support.

It was confirmed from a sectional photograph of the light-reflecting layer and the phosphor layer, which was obtained by using a scanning electron microscope, that there was no interface therebetween.

On the phosphor layer was placed a transparent polyethylene terephthalate film (thickness: 10 μm ; provided with a polyester adhesive layer on one surface) to combine the transparent film and the phosphor layer with the adhesive layer.

Thus, a radiation image storage panel consisting essentially of a support, a light-reflecting layer, a phosphor layer and a transparent protective film was prepared.

Comparison Example 7

The procedure of Example 8 was repeated except for not using the epoxy resin and using 120 g. of the linear polyester resin in the preparation of the coating dispersion I wherein the ratio of binder to white pigment was 1 : 2, by weight, to prepare a radiation image storage panel consisting essentially of a support, a light-reflecting layer, a phosphor layer and a transparent protective film.

Example 9

To 214 g. of particulate barium fluorobromide (BaFBr , which contained 90 % of particles having a diameter ranging 1 - 5 μm) were added 25.7 g. (solid content) of a soft acrylic resin, 64 g. of a methyl ethyl ketone solution of nitrocellulose having a nitration degree of 11.5 % (solid content: 10 wt.%), 10.7 g. of a bisphenol A-type epoxy resin having an average molecular weight of 500 and further methyl ethyl ketone. The mixture was sufficiently stirred by means of a propeller agitator to obtain a homogeneous dispersion (coating dispersion I) having a mixing ratio of 1 : 5 (binder containing epoxy resin : BaFBr , by weight) and a viscosity of 25 - 35 PS (at 25 DEG C).

To 300 g. of a particulate divalent europium activated barium fluorobromide ($\text{BaFBr}0.8\text{I}0.2:0.001\text{Eu}^{2+}$) stimuable phosphor were added 7.0 g. (solid content) of the soft acrylic resin, 15 g. of the nitrocellulose solution (solid content: 10 wt.%), 1.5 g. of the bisphenol A-type epoxy resin and further methyl ethyl ketone. The mixture was sufficiently stirred by means of a propeller agitator to obtain a homogeneous dispersion of phosphor (coating dispersion II) having a mixing ratio of 1 : 30 (binder : phosphor, by weight) and a viscosity of 25 - 35 PS (at 25 DEG C).

Independently, 90 g. of (solid content) of the soft acrylic resin, 50 g. of the nitrocellulose solution (solid content: 10 wt.%) and further methyl ethyl ketone were sufficiently mixed by means of a propeller agitator, to obtain a coating dispersion for a subbing layer having a viscosity of 3 - 6 PS (at 25 DEG C).

The coating dispersion was applied evenly onto a polyethylene terephthalate sheet containing carbon black (support, thickness: 300 μm) placed horizontally on a glass plate by using a doctor blade. Subsequently, the support having a layer of the coating dispersion was heated at a temperature gradually rising from 25 to 100 DEG C, to form a subbing layer on the support.

Then, The coating dispersion I was initially applied evenly onto the subbing layer provided on the support placed horizontally on the glass plate by using the doctor blade. Immediately, the coating dispersion II was applied onto a layer of the coating dispersion I in the same manner as quickly as the solvent of the coating dispersion I was not removed. After the coating was complete, the support having superposed layers of the coating dispersions I and II was placed in an oven and heated at a temperature gradually rising from 25 to 100 DEG C, to simultaneously form a light-reflecting layer having a thickness of 60 μm and a phosphor layer having a thickness of 280 μm on the subbing layer.

On the phosphor layer was placed a transparent polyethylene terephthalate film (thickness: 10 μm ; provided with a polyester adhesive layer on one surface) to combine the transparent film and the phosphor layer with the adhesive layer.

Thus, a radiation image storage panel consisting essentially of a support, a subbing layer, a light-reflecting layer, a phosphor layer and a transparent protective film was prepared.

Comparison Example 8

The procedure of Example 9 was repeated except for not using the epoxy resin and using 36.4 g. (solid content) of the soft acrylic resin in the preparation of the coating dispersion I wherein the ratio of binder to BaFBr was 1 : 5, by weight, to prepare a radiation image storage panel consisting essentially of a support, a subbing layer, a light-reflecting layer, a phosphor layer and a transparent protective film.

The radiation image storage panels obtained in Examples 8 and 9 and Comparison Examples 7 and 8 were measured on the sensitivity in the same manner as described hereinbefore. The results are set forth in Table 6. EMI47.1

As is evident from Table 6, the light-reflecting layers, each of which contained the epoxy group-containing compound, of the radiation image storage panels of the invention (Examples 8 and 9) were prevented from yellowing, and said panels were remarkably improved in the sensitivity as compared with the radiation image storage panels wherein the epoxy group-containing compound was not contained in the light-reflecting layers (Comparison Examples 7 and 8), respectively.

Example 10

A polyacrylic resin (trade name: Dianal BR107, available from Mitsubishi Rayon Co., Ltd.), aliphatic isocyanate (crosslinking agent, trade name: Desmodul Z4370, available from Sumitomo Bayer Urethane Co., Ltd.), nitrocellulose (trade name: RS120, available from Daicel Co., Ltd.), silicon dioxide (particle diameter: 2 - 3 μm) and a bisphenol A-type epoxy resin having an average molecular weight of 800 were added to methyl ethyl ketone in the following composition, to prepare a coating dispersion for a subbing layer having a viscosity of 2.5 - 6 PS (at 25 DEG C).

Composition of Coating Dispersion for Subbing Layer

Polyacrylic resin 100 g.
Aliphatic isocyanate 3 g.
Nitrocellulose 3 g.
Silicon dioxide 20 g.
Epoxy resin 10 g.

The coating dispersion was applied evenly onto a polyethylene terephthalate sheet containing carbon black (support, thickness: 250 μm) placed horizontally on a glass plate by using a doctor blade. Subsequently, the support having a layer of the coating dispersion was heated at a temperature gradually rising from 25 to 100 DEG C, to form a subbing layer having a thickness of 30 μm on the support.

A particulate divalent europium activated barium fluorobromide ($\text{BaFBr}0.85\text{I}0.15:0.001\text{Eu}^{2+}$) stimuable phosphor, the above-mentioned polyacrylic resin, nitrocellulose and epoxy resin were added to methyl ethyl ketone in the following composition, and they were sufficiently mixed by means of a propeller agitator to prepare a homogeneous coating dispersion for a phosphor layer having a mixing ratio of 1 : 30 (binder : phosphor, by weight) and a viscosity of 25 - 35 PS (at 25 DEG C).

Composition of Coating Dispersion for Phosphor Layer

$\text{BaFBr}0.85\text{I}0.15:0.001\text{Eu}^{2+}$ 120.0 g.
Polyacrylic resin 3.2 g.
Nitrocellulose 0.4 g.
Epoxy resin 0.4 g.

The coating dispersion was applied evenly onto the subbing layer provided on the support using the doctor blade. After the coating was complete, the support having a layer of the coating dispersion was heated to dryness in an air of a temperature of 90 DEG C and of a flow rate of 1.0 m/sec. for 10 min, to form a phosphor layer having a thickness of 150 μm on the subbing layer.

On the phosphor layer was placed a transparent polyethylene terephthalate film (thickness: 12 μm ; provided with a polyester adhesive layer on one surface) to combine the transparent film and the phosphor layer with the adhesive layer.

Thus, a radiation image storage panel consisting essentially of a support, a subbing layer, a phosphor layer and a transparent protective film was prepared.

Comparison Example 9

The procedure of Example 10 was repeated except for not using the epoxy resin and using 110 g. of the polyacrylic resin in the preparation of the coating dispersion for a subbing layer, to prepare a radiation image storage panel consisting essentially of a support, a subbing layer, a phosphor layer and a transparent protective film.

Example 11

The procedure of Example 10 was repeated except for using a polyurethane resin (trade name: Crisbon NT-150, available from Dainippon Ink & Chemicals, Inc.) instead of the polyacrylic resin and the nitrocellulose in the preparation of the coating dispersion for a subbing layer, to prepare a radiation image storage panel consisting essentially of a support, a subbing layer, a phosphor layer and a transparent protective film.

Composition of Coating Dispersion for Subbing Layer

Polyurethan resin 100 g.
Silicon dioxide 20 g.
Epoxy resin 10 g.

Comparison Example 10

The procedure of Example 11 was repeated except for not using the epoxy resin and using 110 g. of the polyurethane resin in the preparation of the coating dispersion for a subbing layer, to prepare a radiation image storage panel consisting essentially of a support, a subbing layer, a phosphor layer and a transparent protective film.

The radiation image storage panels obtained in Examples 10 and 11 and Comparison Examples 9 and 10 were measured on the sensitivity in the same manner as described above. The results are set forth in Table 7. EMI50.1

As is evident from Table 7, the subbing layers and the phosphor layers, which contained the epoxy group-containing compound, of the radiation image storage panels of the invention (Examples 10 and 11) were prevented from yellowing, and said panels were remarkably improved in the sensitivity as compared with the radiation image storage panels wherein the epoxy group-containing compound was not contained in the subbing layer (Comparison Examples 9 and 10), respectively.

Example 12

A subbing layer and a phosphor layer were formed on a support in the same manner as described in Example 10.

A polyester resin (adhesive agent, trade name: Vylon #300, available from Toyobo Co., Ltd.) and a bisphenol A-type epoxy resin having an average molecular weight of 800 were added to methyl ethyl ketone in the following composition, to prepare a 2 wt.% solution of the adhesive agent.

Composition of Solution of Adhesive Agent

Polyester 1.9 g.
Epoxy resin 0.1 g.
Methyl ethyl ketone 98 g.

The solution was applied evenly onto a transparent polyethylene terephthalate film (protective film, thickness: 10 μ m) by using a doctor blade to form a layer of the solution. Subsequently, the transparent film was laminated on the phosphor layer through the layer of the solution, to form an adhesive layer having a thickness of 1.5 μ m and a transparent protective film on the phosphor layer

Thus, a radiation image storage panel consisting of a support, a subbing layer, a phosphor layer, an adhesive layer and a transparent protective film was prepared.

Comparison Example 11

The procedure of Example 12 was repeated except for not using the epoxy resin and using 2.0 g. of the polyester resin in the preparation of the solution of the adhesive agent, to prepare a radiation image storage panel consisting of a support, a subbing layer, a phosphor layer, an adhesive layer and a transparent protective film.

The radiation image storage panels obtained in Example 12 and Comparison Example 11 were evaluated on the sensitivity and the deterioration characteristics according to the following tests.

(1) Sensitivity

The radiation image storage panel was exposed to X-rays at 80 KVp and then excited with a He-Ne laser beam (632.8 nm), to measure the sensitivity.

(2) Deterioration characteristics

After the radiation image storage panel was allowed to stand at a temperature of 60 DEG C and at a humidity of 80 %RH for one week, the panel was measured on the sensitivity in the same manner as described above.

The results are set forth in Table 8. EMI53.1

As is evident from Table 8, the subbing layer, the phosphor layer and the adhesive layer, each of which contained the epoxy group-containing compound, of the radiation image storage panel according to the invention (Example 12) were prevented from yellowing just after the preparation thereof, and said panel showed the high sensitivity just after the preparation and the good resistance to deterioration with time, as compared with the radiation image storage panel wherein the epoxy group-containing compound was not contained in the adhesive layer (Comparison Example 11).

Example 13

A particulate divalent europium activated barium fluorobromide ($\text{BaFBr}0.85\text{I}0.15:0.001\text{Eu}^{2+}$) stimuable phosphor, a polyurethane resin (trade name: Pandex T-5265M, available from Dainippon Ink & Chemicals Inc.), nitrocellulose (trade name: RS120, available from Daicel Co., Ltd.), a bisphenol A-type epoxy resin having an average molecular weight of 800 and alkyldiallyl phosphite were added to a mixture of methyl ethyl ketone and toluene (having a ratio of 1 : 1, in volume) in the following composition, and they were sufficiently mixed by means of a propeller agitator to prepare a homogeneous coating dispersion I for a phosphor layer having a mixing ratio of 1 : 30 (binder : phosphor, by weight) and a viscosity of 25 - 35 PS (at 25 DEG C).

Composition of Coating Dispersion I

$\text{BaFBr}0.85\text{I}0.15:0.001\text{Eu}^{2+}$ 600 g.

Polyurethane resin 15.8 g.

Nitrocellulose 2.0 g.

Epoxy resin 2.0 g.

Alkyldiallyl phosphite 0.2 g.

Independently, a polyurethane resin (trade name: Desmolac 4200, available from Sumitomo Bayer Urethane Co., Ltd.), the above-mentioned nitrocellulose, aliphatic isocyanate (crosslinking agent, trade name: Desmodul Z4370, available from the same) and alkyldiallyl phosphite were added to a mixture of toluene and isopropyl alcohol (having a ratio of 1 : 1, in volume) in the following composition, to prepare a coating dispersion II for a protective film having a viscosity of 2 - 3 PS (at 25 DEG C).

Composition of Coating Dispersion II

Polyurethane resin 6.9 g.

Nitrocellulose 2.0 g.

Aliphatic isocyanate 1.0 g.

Alkyldiallyl phosphite 0.1 g.

The coating dispersion I and the coating dispersion II were simultaneously applied in a superposing manner onto a polyethylene terephthalate sheet containing carbon black (support, thickness: 250 μm) placed horizontally on a glass plate by using a two-hopper type coating apparatus. After the coating was complete, the support having superposed layers of the coating dispersions I and II was heated at a temperature gradually rising from 25 to 100 DEG C, to form a phosphor layer having a thickness of 250 μm and a protective film having a thickness of 10 μm on the support.

Thus, a radiation image storage panel consisting of a support, a phosphor layer and a protective film was prepared.

Example 14

The procedure of Example 13 was repeated except for further using 0.5 g. of the epoxy resin and using 6.4 g. of the polyurethane resin in the preparation of the coating dispersion II, to prepare a radiation image storage panel consisting of a support, a phosphor layer and a protective film.

Comparison Example 12

The procedure of Example 13 was repeated except for not adding the alkyldiallyl phosphite to the coating dispersion II, to prepare a radiation image storage panel consisting of a support, a phosphor layer and a protective film.

The radiation image storage panels obtained in Examples 13 and 14 and Comparison Example 12 were evaluated on the sensitivity and the deterioration characteristics according to the following test.

(1) Sensitivity

The radiation image storage panel was exposed to X- rays at 80 KVp and then excited with a He-Ne laser beam (632.8 nm), to measure the sensitivity.

(2) Deterioration characteristics

After the radiation image storage panel was allowed to stand at a temperature of 60 DEG C and at a humidity of 80 %RH for one week, the panel was measured on the sensitivity in the same manner as described above.

After the radiation image storage panel was exposed to light in an amount of 100,000 lux for 3 hrs. using a high-voltage sodium lamp, the panel was measured on the sensitivity in the same manner as described above.

The results are set forth in Table 9. EMI56.1

As is evident from Table 9, the phosphor layer and the protective film, which contained the phosphite, of the radiation image storage panel according to the invention (Example 13) were prevented from yellowing just after the preparation thereof, and said panel was remarkably improved in sensitivity as compared with the radiation image storage panel wherein the phosphite was not contained in the protective film (Comparison Example 12).

Further, the radiation image storage panel wherein both the phosphite and the epoxy group-containing compound were contained in the protective film according to the invention (Example 14) was more improved in the resistance to deterioration with time and the resistance to light than the panel of Example 13.

Example 15

A phosphor layer and a protective film were formed on a support in the same manner as described in Example 13, to prepare a radiation image storage panel consisting of a support, a phosphor layer and a protective film.

Then, a vinyl chloride-vinyl acetate copolymer (trade name: SVR VYHH, available from Union Carbide Corp.), a polyacrylic resin (trade name: Dianal BR102, available from Mitsubishi Rayon Co., Ltd.) and a bisphenol A-type epoxy resin having an average molecular weight of 800 were added to methyl ethyl ketone in the following composition, to prepare a coating dispersion for a covering having a viscosity of 2 PS (25 DEG C).

Composition of Coating Dispersion for Covering

Vinyl chloride-vinyl acetate copolymer 6.0 g.

Polyacrylic resin 3.0 g.

Epoxy resin 1.0 g.

The coating dispersion was applied onto the side surfaces of the panel and subsequently the panel was dried at a room temperature for about 1 hour, to form a polymer film having a thickness of 30 +/- 10 μm on the side surfaces.

Thus, a radiation image storage panel whose side surfaces were covered with a polymer film was obtained.

Comparison Example 13

The procedure of Example 15 was repeated except for not using the epoxy resin and using 7.0 g. of the vinyl chloride-vinyl acetate copolymer in the preparation of the coating dispersion for a covering, to prepare a radiation image storage panel consisting of a support, a phosphor layer and a protective film and covered with a polymer film.

The radiation image storage panels obtained in Example 15 and Comparison Example 13 were observed with eyes. As a result, the panel wherein the epoxy group-containing compound and/or the phosphite were contained in the polymer film for covering, the phosphor layer and the protective film according to the invention (Example 15) was completely free from yellowing. On the contrary, the polymer film of the panel (Comparison Example 13), which did not contain the epoxy group-containing compound, was colored yellow.

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Radiation image storage panel

Claims of EP0234385

1. A radiation image storage panel comprising a support and a phosphor layer provided on the support which comprises a binder and a stimuable phosphor dispersed therein, characterized in that said stimuable phosphor is a phosphor containing iodine and that said phosphor layer contains a compound having an epoxy group and/or at least one compound selected from the group consisting of phosphites, organotin compounds and metal salts of organic acids.
2. The radiation image storage panel as claimed in claim 1, in which said compound having an epoxy group is contained in the phosphor layer in an amount of 0.001 - 10 % by weight of the stimuable phosphor.
3. The radiation image storage panel as claimed in claim 2, in which said compound having an epoxy group is contained in the phosphor layer in an amount of 0.03 - 3 % by weight of the stimuable phosphor.
4. The radiation image storage panel as claimed in claim 1, in which said compound having an epoxy group is at least one compound selected from the group consisting of 1,2-epoxypropane, 1,2-epoxybutane and an epoxy resin.
5. The radiation image storage panel as claimed in claim 1, in which said at least one compound selected from the group consisting of phosphites, organotin compounds and metal salts of organic acids is contained in the phosphor layer in an amount of 0.0001 - 3 % by weight of the stimuable phosphor.
6. The radiation image storage panel as claimed in claim 5, in which said at least one compound selected from the group consisting of phosphites, organotin compounds and metal salts of organic acids is contained in the phosphor layer in an amount of 0.003 - 0.3 % by weight of the stimuable phosphor.
7. The radiation image storage panel as claimed in claim 1, in which said phosphites are compounds having the formula (I) and compounds having the formula (II): EMI60.1 in which A is an oxygen atom or a sulfur atom; each of R<1>, R<2>, R<3> and R<4> is a hydrogen atom, an alkyl group or an aryl group, and R<1>, R<2>, R<3> and R<4> are the same or different from each other; and X<1> is a group comprising a carbon atom and/or an oxygen atom and/or a hydrogen atom.
8. The radiation image storage panel as claimed in claim 1, in which said organotin compounds are compounds having the formula (III): EMI61.1 in which each of R<5> and R<6> is a hydrogen atom, an alkyl group or an aryl group, and R<5> and R<6> are the same or different from each other; each of Y<1>, Y<2>, Y<3> and Y<4> is an alkyl group, an aryl group, a fatty acid, a fatty acid derivative, mercaptan or a mercaptan carboxylic acid, and Y<1>, Y<2>, Y<3> and Y<4> are the same or different from each other; X<2> is an oxygen atom, a sulfur atom or a maleic acid; and n is 0 or an integer of not less than 1.
9. The radiation image storage panel as claimed in claim 1, in which said metal salts of organic acids are compounds having the formula (IV):
(R<7>COO)mM (IV)
in which R<7> is an alkyl group or an aryl group having 1 - 20 carbon atoms, which may have at least one substituent; M is calcium, zinc, cadmium or barium; and m is a positive integer.
10. The radiation image storage panel as claimed in claim 1, in which said stimuable phosphor is at least one phosphor selected from the group consisting of divalent europium activated alkaline earth metal fluorohalide phosphors containing iodine, divalent europium activated alkaline earth metal halide phosphors containing iodine, rare earth element activated rare earth oxyhalide phosphors containing iodine and bismuth activated alkali metal halide phosphors containing iodine.
11. The radiation image storage panel as claimed in claim 1, in which said panel comprises a support, a light-reflecting layer containing a light-reflecting material and a phosphor layer, and said light-reflecting layer contains a compound having an epoxy group and/or at least one compound selected from the group consisting of phosphites, organotin compounds and metal salts of organic acids.

12. The radiation image storage panel as claimed in claim 11, in which said compound having an epoxy group is contained in the light-reflecting layer in an amount of 0.001 - 10 % by weight of the light-reflecting material.

13. The radiation image storage panel as claimed in claim 11, in which said at least one compound selected from the group consisting of phosphites, organotin compounds and metal salts of organic acids is contained in the light-reflecting layer in an amount of 0.0001 - 3 % by weight of the light-reflecting material.

14. The radiation image storage panel as claimed in claim 1, in which said panel comprises a support, a subbing layer comprising a resin and a phosphor layer, and said subbing layer contains a compound having an epoxy group and/or at least one compound selected from the group consisting of phosphites, organotin compounds and metal salts of organic acids.

15. The radiation image storage panel as claimed in claim 14, in which said compound having an epoxy group is contained in the subbing layer in an amount of 0.03 - 100 % by weight of the resin.

16. The radiation image storage panel as claimed in claim 14, in which said at least one compound selected from the group consisting of phosphites, organotin compounds and metal salts of organic acids is contained in the subbing layer in an amount of 0.003 - 30 % by weight of the resin.

17. The radiation image storage panel as claimed in claim 1, in which said panel comprises a support, a phosphor layer and a protective film comprising a polymer material, and said protective film contains a compound having an epoxy group and/or at least one compound selected from the group consisting of phosphites, organotin compounds and metal salts of organic acids.

18. The radiation image storage panel as claimed in claim 17, in which said compound having an epoxy group is contained in the protective film in an amount of 0.03 - 100 % by weight of the polymer material.

19. The radiation image storage panel as claimed in claim 17, in which said at least one compound selected from the group consisting of phosphites, organotin compounds and metal salts of organic acids is contained in the protective film in an amount of 0.003 - 30 % by weight of the polymer material.

20. The radiation image storage panel as claimed in claim 1, in which said panel comprises a support, a phosphor layer, an adhesive layer comprising an adhesive agent and a protective film, and said adhesive layer contains a compound having an epoxy group and/or at least one compound selected from the group consisting of phosphites, organotin compounds and metal salts of organic acids.

21. The radiation image storage panel as claimed in claim 20, in which said compound having an epoxy group is contained in the adhesive layer in an amount of 0.03 - 100 % by weight of the adhesive agent.

22. The radiation image storage panel as claimed in claim 20, in which said at least one compound selected from the group consisting of phosphites, organotin compounds and metal salts of organic acids is contained in the adhesive layer in an amount of 0.003 - 30 % by weight of the adhesive agent.

23. The radiation image storage panel as claimed in claim 1, in which the side surface of said panel are covered with a polymer material and said polymer material contains a compound having an epoxy group and/or at least one compound selected from the group consisting of phosphites, organotin compounds and metal salts of organic acids.

24. The radiation image storage panel as claimed in claim 23, in which said compound having an epoxy group is contained in the polymer material in an amount of 0.1 - 100 % by weight of the polymer material.

25. The radiation image storage panel as claimed in claim 23, in which said at least one compound selected from the group consisting of phosphites, organotin compounds and metal salts of organic acids is contained in the polymer material in an amount of 0.01 - 10 % by weight of the polymer material.

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